

G./Blasse, B. C./Grabmaier

620.1391  
B 620.1391

# Luminescent Materials

With 171 Figures and 31 Tables

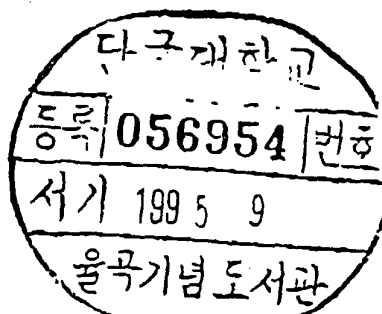
Prof. Dr. G. Blasse

Debye Institute  
University Utrecht  
Postbox 80.000  
3508 TA Utrecht  
The Netherlands

Prof. Dr. B. C. Grabmaier

Siemens Research Laboratories  
ZFE BT MR 22  
D-81730 München  
Germany

also with Debye Institute  
University Utrecht



ISBN 3-540-58019-0 Springer-Verlag Berlin Heidelberg New York  
ISBN 0-387-58019-0 Springer-Verlag New York Berlin Heidelberg

Library of Congress Cataloging-in-Publication Data  
Blasse, G. Luminescent materials / G. Blasse, B.C. Grabmaier. p. cm.  
Includes bibliographical references and index.  
ISBN 3-540-58019-0. -- ISBN 0-387-58019-0 (U.S.)



Fig. 7.4. Scanning electron microscope photograph of particles of the  $Y_2O_2S:Eu$  phosphor. (reproduced with permission from Ref. [1])

cathode-ray tubes. In order to produce color tubes, predominantly a slurry method is used. Further a dusting and an electrophoretic method can be used. For more details on screening, see Ref. [1].

### 7.3 Cathode-Ray Phosphors

As a consequence the band gap decreases, so that the emission wavelength shifts to the red. Actually  $\text{Zn}_{0.88}\text{Cd}_{0.12}\text{S}:\text{Ag}^+$  is a green-, and  $\text{Zn}_{0.13}\text{Cd}_{0.87}\text{S}:\text{Ag}^+$  a red-emitting cathode-ray phosphor. The emission color is not determined by the nature of the luminescent center, but by the value of the band gap. Figure 7.2 shows the chromaticity diagram with three phosphors from the  $(\text{Zn,Cd})\text{S}:\text{Ag}^+$  family.

However, the  $(\text{Zn,Cd})\text{S}$  system has several disadvantages. In the first place, the use of cadmium has become unacceptable for environmental reasons. The red phosphor on this basis has still another large disadvantage, viz. in order to obtain red emission the larger part of the broad band emission of this phosphor is situated in the near infrared. The maximum of the emission band is close to 680 nm. This implies that the lumen equivalent of this phosphor is low (25%). For  $\text{Y}_2\text{O}_3\text{S}:\text{Eu}^{3+}$  with line emission this is 55% [1].

Long ago it was predicted that color television with a satisfying brightness would only be possible with a phosphor which emits in the red by line emission around 610 nm [2]. Now we know that only the  $\text{Eu}^{3+}$  ion is able to satisfy this requirement. In fact the introduction of  $\text{Eu}^{3+}$ -activated phosphors in the color-television tube was a breakthrough: not just the red, but the total brightness increased strongly. It was also the introduction of rare-earth phosphors leading to many other improvements (e.g. in luminescent lamps) and the end of the domination of the sulfides.

### 7.3.2 Phosphors for Black-and-White Television [3]

In a sense this is a historical paragraph. The color preferred for black-and-white television is bluish-white. This can be realized by many combinations of two phosphors as prescribed by the chromaticity diagram. The best is  $\text{ZnS}:\text{Ag}^+$  and (yellow-emitting)  $\text{Zn}_{0.5}\text{Cd}_{0.5}\text{S}:\text{Ag}^+$  or  $\text{Zn}_{0.9}\text{Cd}_{0.1}\text{S}:\text{Cu,Al}$ . Single-component white phosphors have also been found, but none has found practical application.